AN INVESTIGATION THE EFFECT OF STATOR SLOT OPTIMIZATION IN 0.5HP THREE PHASE INDUCTION MOTOR VIA FEM

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ABSTRACT: *A study of stator slot design for induction motor is necessary in order to additional improvement of efficiency and reduces the winding loss. By using FEM, the motor parameters as well as the losses and the efficiency between the different stator slot sizes is estimate and the result is presented. The results shows that the optimal stator slot model which is the stator with slot size 8mm has lower winding loss and total loss compared to initial stator slot model which is the stator with slot size 6mm. Thus, a 2.92% of the efficiency was improved as reduction of winding loss and total loss at the optimal stator slot model.*

1. INTRODUCTION

Induction machine is the most used of all electric motors. It is generally easy to build and cheaper than corresponding dc or synchronous motors. The induction motors is rugged and require little maintenance [1]. The ac induction consists of stationary member, called the stator and the rotating member, called the rotor. AC power is used to energize the stator windings.

A study of stator slot design for induction motor is necessary in order to additional improvement of efficiency and reduces the winding loss.

The finite element method is now well documented. It allows the estimation of the induction motor parameters with a reasonably high accuracy. In this investigation, finite element method (FEM) is used as the main tool in the estimation of motor parameters as well as the losses and the efficiency between the different stator slot sizes.

2. MATERIAL AND METHODS

2.1 Design Specification

Two models of the three phase induction motor stators between different stator slot size used in this investigation. The initial model is the stator with slot size 6mm and the optimal model is the stator with slot size 8mm as in Fig. 1 and Fig. 2.

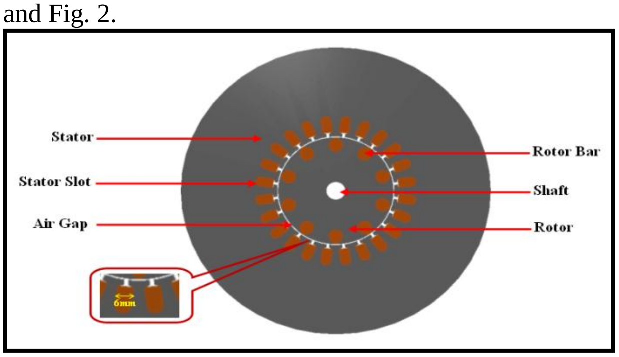


Fig. 1 Cross sectional part of induction motor design for stator slot size 6mm by FEM

Table 1 shows the stator specification of the induction motor. This parameter is important as it is used to simulate the FEM software. From this, the result of motor parameters as well as the losses and the efficiency of the two stator slot design are obtained. The stator teeth are design with parallel sides to avoid localized saturation within the teeth [2].

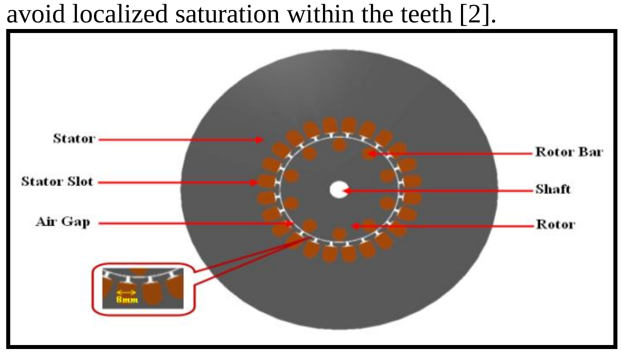


Fig. 2 Cross sectional part of induction motor design for stator slot size 8mm by FEM

Table: 1 Design specification of induction motor

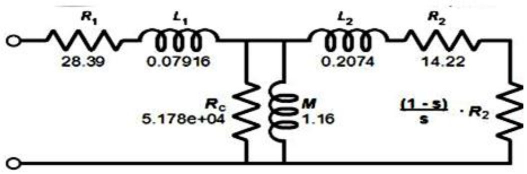
Motor parameter	Value
Horse power	0.5
Phase [Φ]	3
Pole	4
Frequency [Hz]	50
Electrical steel material thickness [mm]	0.35
Outer diameter of stator[mm]	180
Inner diameter of stator[mm]	68
Stator slot width of initial model [mm]	6
Stator slot width of optimal model [mm]	8
Number of Stator slot	24

3. RESULTS AND DISCUSSION

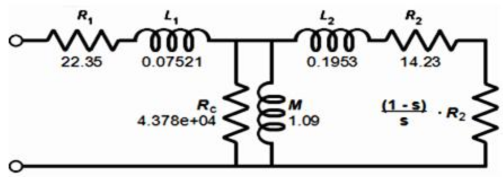
Finite element analysis (FEA) is used to examine the stator copper loss and efficiency between two stator models. The results of comparison between two different stator slot size which is 6mm and 8mm is described in many aspects from the simulation of FEM is shown below.

3.1 Equivalent Circuit

The parameters of the 0.5HP induction motor equivalent circuit of two different stator slot size are shown in Fig. 3.



(a) Stator slot size 6mm



(b) Stator slot size 8mm

Fig. 3 0.5Hp induction motor parameter (equivalent circuit) for both stator slot size

3.2 Equivalent Circuit Analysis

The results of AC analysis for stator slot size 6mm and 8mm are shown in Fig. 4 and Fig. 5 respectively. The tests are based on FEA solves and include accurate estimation of stator copper loss or winding loss and also the efficiency.

6mm, 100% rated speed		
Rotor speed (RPM)	Rotor slip (%)	Loss (watts)
0	100	613.42465
75	95	609.79031
150	90	605.72639
225	85	601.15497
300	80	595.97876
375	75	590.07493
450	70	583.2865
525	65	575.41011
600	60	566.17852
675	55	555.23487
750	50	542.09461
825	45	526.08794
900	40	506.27219
975	35	481.29859
1050	30	449.21533
1125	25	407.20646
1200	20	351.3772
1275	15	277.18227
1350	10	182.85112
1425	5	81.354820
1500	0	32.036511

Fig. 4 Winding loss data of stator slot size 6mm from ac analysis

Based on the result as shown in Fig. 4 and Fig. 5, graphs such as the loss (Watts) vs. speed (rpm) are plotted as shown in Fig. 6. In this investigation, by increasing the stator slot size from 6mm to 8mm, 14.27% of stator copper loss can be reduced. This is due to the increase of the stator slot size will decrease the resistance of the stator coil, thus the stator copper loss is reduced [3]. This loss will contribute to the variation in the motor efficiency.

8mm, 100% rated speed		
Rotor speed (RPM)	Rotor slip (%)	Loss (watts)
0	100	562.56172
75	95	559.21004
150	90	555.45126
225	85	551.21012
300	80	546.39248
375	75	540.8792
450	70	534.51773
525	65	527.1101
600	60	518.39579
675	55	508.02677
750	50	495.53064
825	45	480.25566
900	40	461.28854
975	35	437.33295
1050	30	406.53955
1125	25	366.30739
1200	20	313.21149
1275	15	243.71175
1350	10	157.81641
1425	5	69.776564
1500	0	28.571672

Fig. 5 Winding loss data of stator slot size 8mm from ac analysis

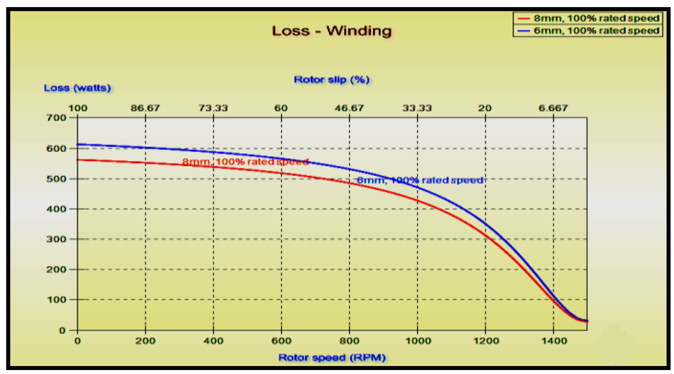


Fig. 6 Graph of stator copper loss for stator slot width 8mm and 6mm

The reduction of stator copper loss can improve the motor efficiency as shown in Fig. 7. So, even a minor improvement, this can save several amount of energy that was consumed by the induction motor [4].

From the graph in Fig. 7, the efficiency of stator slot size 8mm is 81.16% which is better than efficiency of stator slot size 6mm which is 78.86%. This is due to the losses of stator slot size 8mm is lower than 6mm, thus the efficiency is improved. In this investigation, the increase in stator slot size from 6mm to 8mm can not only reduce the stator copper loss, but also a 2.92% of the efficiency can be improved. Even the efficiency increase of 1 or 2%, it has a crucial effect on the performance of home appliances, as well as on energy savings worldwide [5].

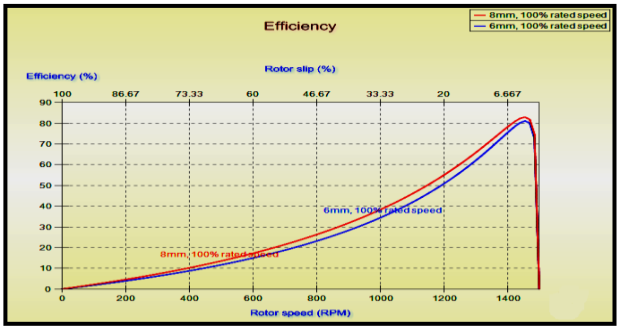


Fig. 7 Graph of efficiency for stator slot width 8mm and 6mm

4. CONCLUSION

The effect of stator slot optimization in 0.5hp three phase induction motor via FEM was proposed. We may conclude from the results that the optimal stator slot model which is the stator with slot size 8mm has lower winding loss and total loss compared to initial stator slot model which is the stator with slot size 6mm. Thus, a 2.92% of the efficiency was improved as reduction of winding loss and total loss at the optimal stator slot model.

5. ACKNOWLEDGEMENTS

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